



Document No. **NNC10ZDM027R**

Extensible Rectangular Nozzle Model Statement of Work

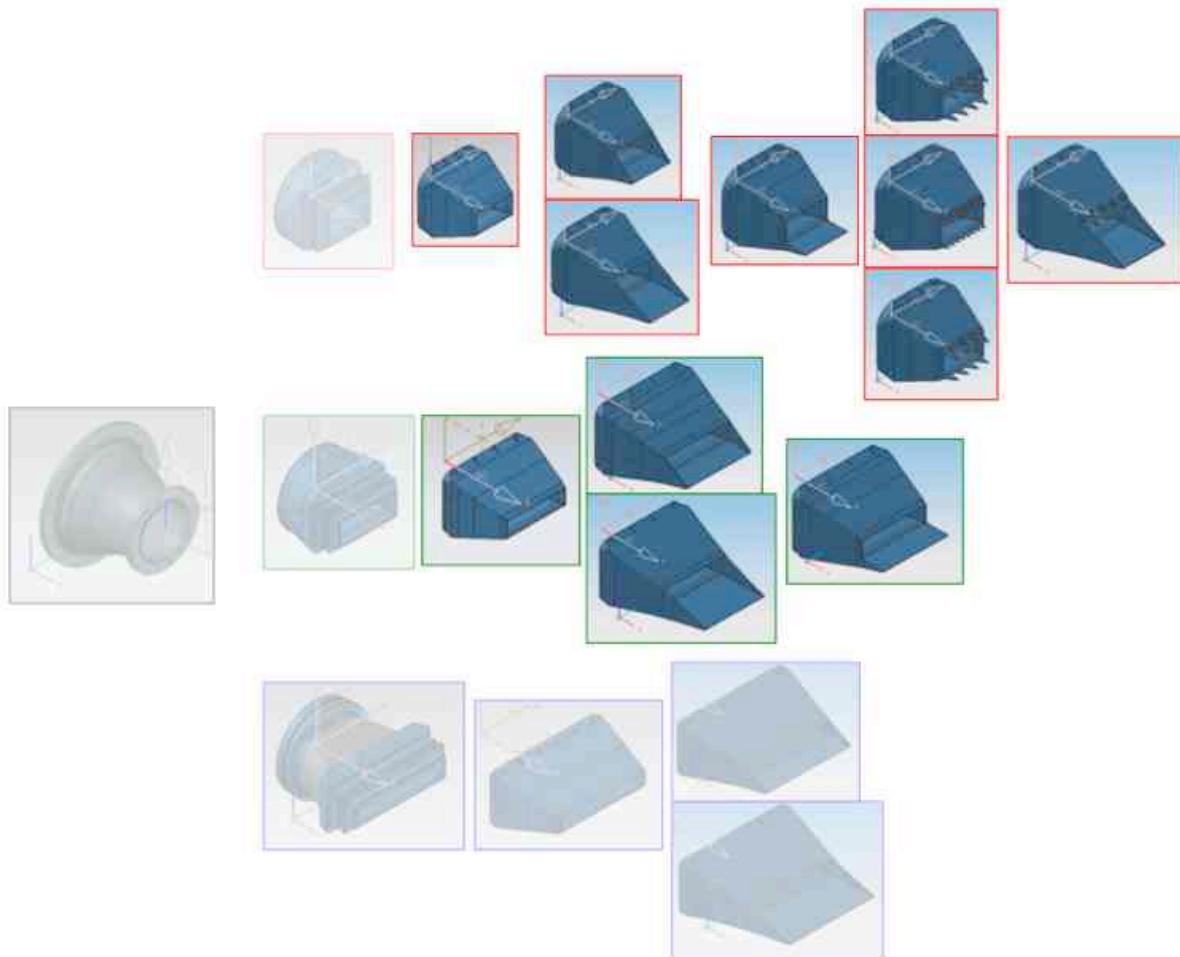




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1. INTRODUCTION

This Statement of Work describes the fabrication of components of the Extensible Rectangular Nozzle Model. The items to be fabricated are identified in the Section 2.0 table. This Model System will be mounted on an existing NASA jet noise rig and will exhaust hot gases up to 1200°F and pressures up to 40psi.

1.1 Scope

The Contractor shall provide manufacturing review, and fabrication services as outlined below. The Name for this group of model hardware is “Extensible Rectangular Nozzle Model”.

1.2 General Description

The Contractor shall complete the fabrication of nozzles as described in this document and in accompanying CAD solid model files. Details of material, manufacturing tolerances and finish are described in this document. The total set consists of 12 nozzles. Final acceptance of the nozzles will require fitting onto a government-provided pieces, the Round to Rectangular Transition Duct, within tolerances specified in this document.

2. PART DESCRIPTIONS

The Extensible Rectangular Nozzle Model is comprised of the parts listed in Table 1. The twelve (12) parts to be fabricated are listed, along with the Part ID, and file names for the solid model files that give the actual part description. Unigraphics v6 (.prt) models are provided for all current part definitions, and STEP or IGES files will be made available upon request.

TABLE 1 LIST OF PARTS TO BE SUPPLIED

| Item | Description | Part ID | File Name |
|------|---------------------------------------|---------|------------------------|
| 1 | Baseline rect nozzle, 2:1 | NA2Z | NA2Z-RevA.prt |
| 2 | Bevel nozzle, 2:1,1.3" ext | NA2B1 | NA2B1-RevA.prt |
| 3 | Bevel nozzle, 2:1, 2.7" ext | NA2B2 | NA2B2-RevA.prt |
| 4 | Cutback nozzle, 2:1, 1.3" ext | NA2K1 | NA2K1-RevA.prt |
| 5 | Chevron nozzle, 2:1, design 1 | NA2C1 | NA2C1-RevB.prt |
| 6 | Chevron nozzle, 2:1, design 2 | NA2C2 | NA2C2-RevB.prt |
| 7 | Chevron nozzle, 2:1, design 3 | NA2C3 | NA2C3-RevB.prt |
| 8 | Bevel nozzle w/chevron, 2:1, design 1 | NA2BC1 | NA2BC1-RevB.prt |
| 9 | Baseline rect nozzle, 4:1 | NA4Z | NA4Z-RevA.prt |
| 10 | Bevel nozzle, 4:1, 1.3" ext | NA4B1 | NA4B1-RevA.prt |
| 11 | Bevel nozzle, 4:1, 2.7" ext | NA4B2 | NA4B2-RevA.prt |
| 12 | Cutback nozzle, 4:1, 1.3" ext | NA4K1 | NA4K1-RevA.prt |

2.1 Additional description of parts

2.1.1 NA2Z, Baseline rectangular nozzle, 2:1

Views of the part are given in Figure 1. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 2.

Inspection points are given in Table 2. See Section 3.2 for details on inspections.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 3.431"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface, shown in Reference cross-section, is considered a mating surface for tolerance and surface finish purposes.

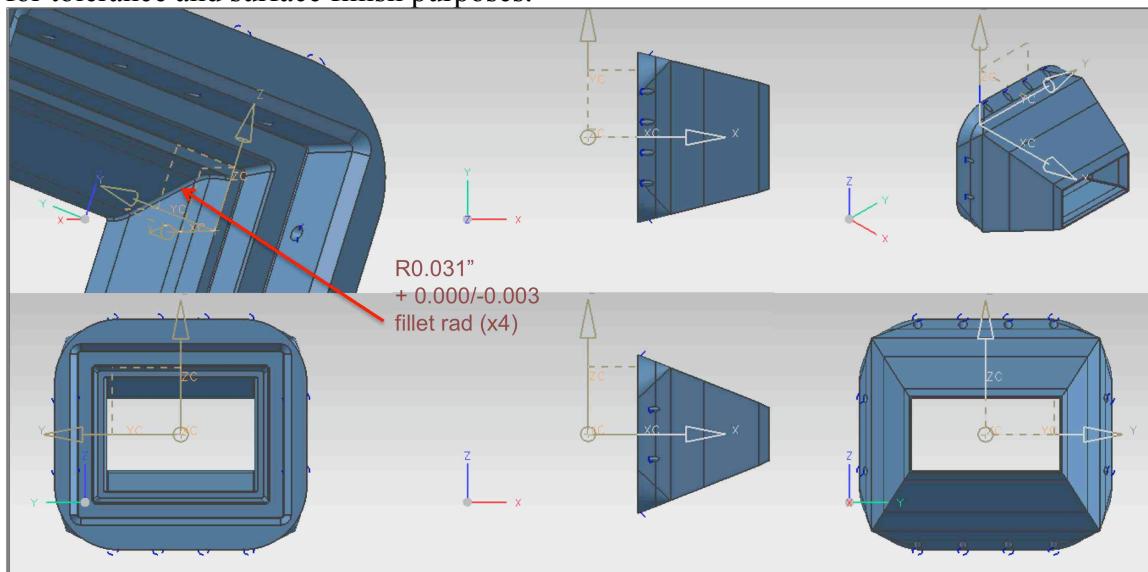


FIGURE 1 PART ID NA2Z—SIX VIEWS

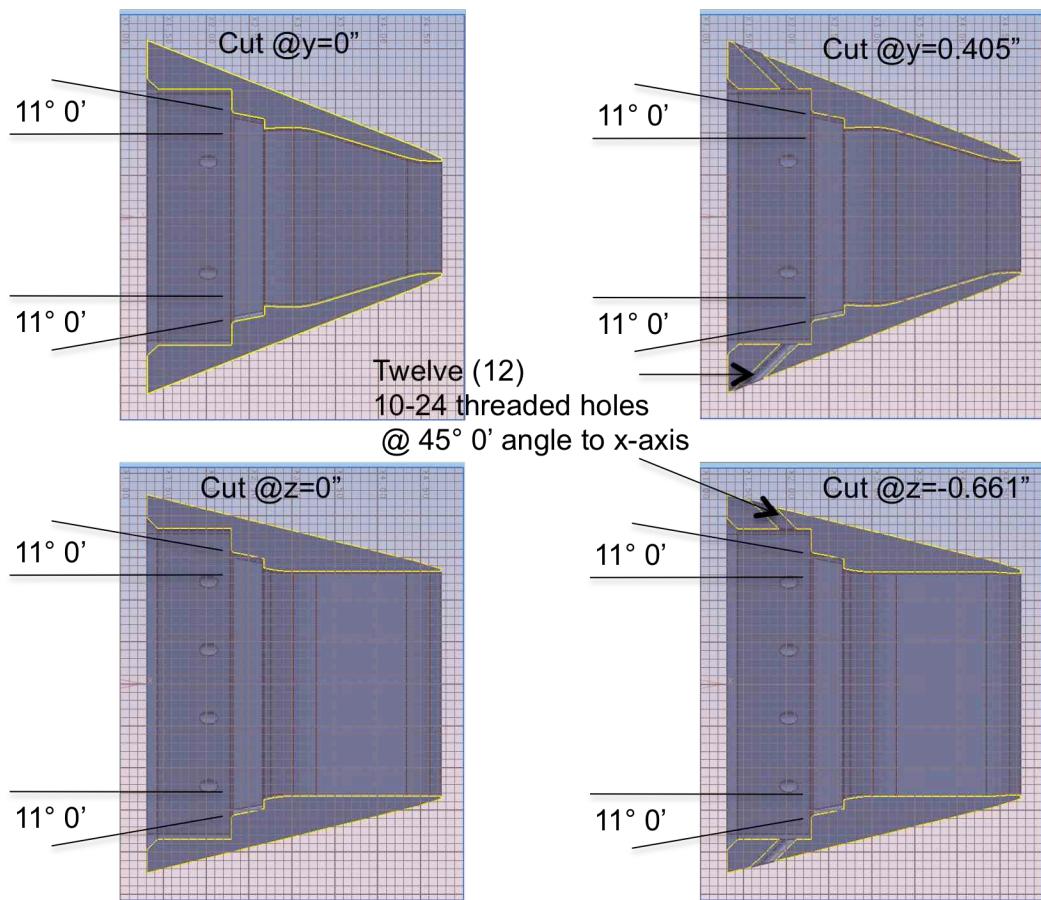


FIGURE 2 PARTID NA2Z—REFERENCE CROSS-SECTIONS

TABLE 2 INSPECTION POINTS FOR PARTID NA2Z

| NA2Z | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|---------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.523 | 1.000 | 0.000 | ±1.697 |
| 1.100 | 0.000 | ±1.221 | 2.931 | 0.000 | ±0.922 |
| 1.300 | 0.000 | ±1.182 | 1.000 | ±1.998 | 0.000 |
| 1.400 | 0.000 | ±1.056 | 2.931 | ±1.513 | 0.000 |
| 1.700 | 0.000 | ±1.068 | | | |
| 3.000 | 0.000 | ±0.717 | | | |
| 3.231 | 0.000 | ±0.670 | | | |
| 3.431 (end) | 0.000 | ±0.667 | | | |
| 0.200 | ±1.850 | 0.000 | | | |
| 1.100 | ±1.543 | 0.000 | | | |
| 1.300 | ±1.504 | 0.000 | | | |
| 1.400 | ±1.368 | 0.000 | | | |
| 1.700 | ±1.335 | 0.000 | | | |
| 3.000 | ±1.335 | 0.000 | | | |
| 3.231 | ±1.335 | 0.000 | | | |
| 3.431 (end) | ±1.335 | 0.000 | | | |

2.1.2 NA2B1, Bevel nozzle, 2:1,1.3" ext

Views of the part are given in Figure 3. Reference cross-sections pointing out location of threaded holes are shown in Figure 4.

Inspection points are given in Table 3.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 4.766"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface, shown in Reference cross-section, is considered a mating surface for tolerance and surface finish purposes.

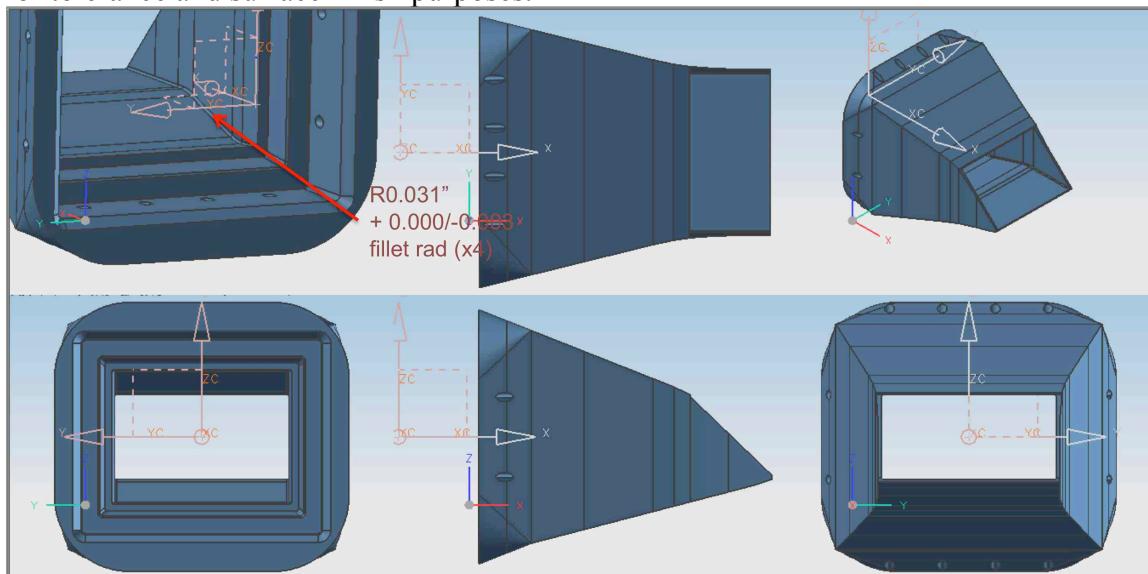


FIGURE 3 PART ID NA2B1—SIX VIEWS

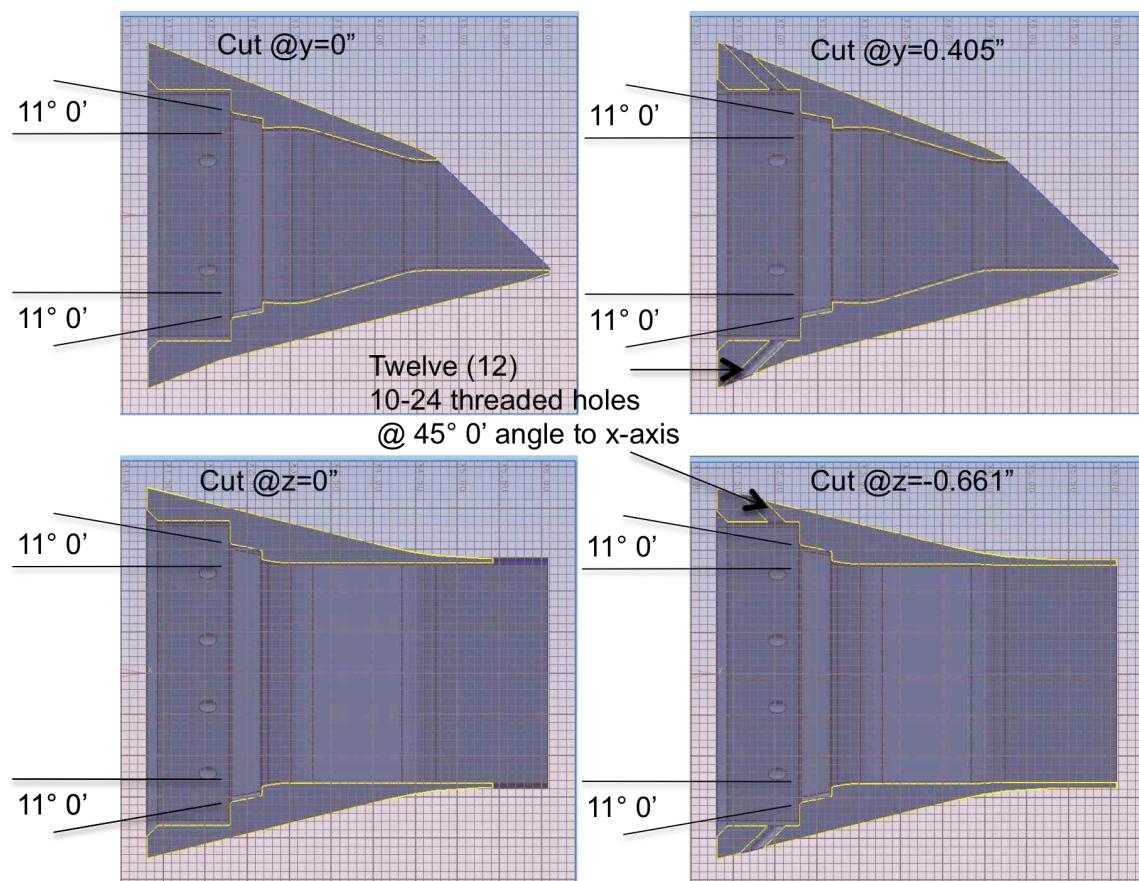


FIGURE 4 PARTID NA2B1—REFERENCE CROSS-SECTION

TABLE 3 INSPECTION POINTS FOR PARTID NA2B1

| NA2B1 | | | | | |
|-------------------|-------------------------------|-------------------------------|-------------------|-------------------------------|-------------------------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ± 1.523 | 1.000 | 0.000 | 1.697 -1.718 |
| 1.100 | 0.000 | ± 1.221 | 2.931 | 0.000 | 0.922 -1.207 |
| 1.300 | 0.000 | ± 1.182 | 1.000 | ± 1.998 | 0.000 |
| 1.400 | 0.000 | ± 1.056 | 2.931 | ± 1.514 | 0.000 |
| 1.700 | 0.000 | ± 1.068 | | | |
| 3.000 | 0.000 | ± 0.717 | | | |
| 3.231 | 0.000 | ± 0.670 | | | |
| 3.431 | 0.000 | ± 0.667 | | | |
| 0.200 | ± 1.850 | 0.000 | | | |
| 1.100 | ± 1.543 | 0.000 | | | |
| 1.300 | ± 1.504 | 0.000 | | | |
| 1.400 | ± 1.368 | 0.000 | | | |
| 1.700 | ± 1.335 | 0.000 | | | |
| 3.000 | ± 1.335 | 0.000 | | | |
| 3.231 | ± 1.335 | 0.000 | | | |
| 3.431 | ± 1.335 | 0.000 | | | |

2.1.3 NA2B2, Bevel nozzle, 2:1, 2.7" ext

Views of the part are given in Figure 5. Reference cross-sections pointing out location of threaded holes are shown in Figure 6.

Inspection points are given in Table 4.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 6.100"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface, shown in Reference cross-section, is considered a mating surface for tolerance and surface finish purposes.

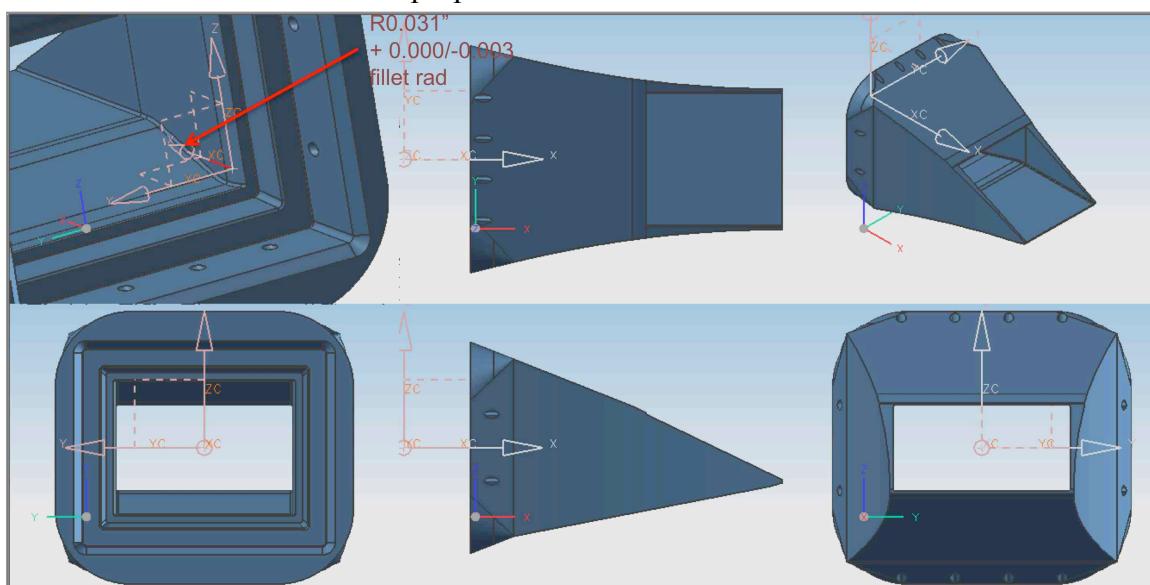


FIGURE 5 PART ID NA2B2—SIX VIEWS

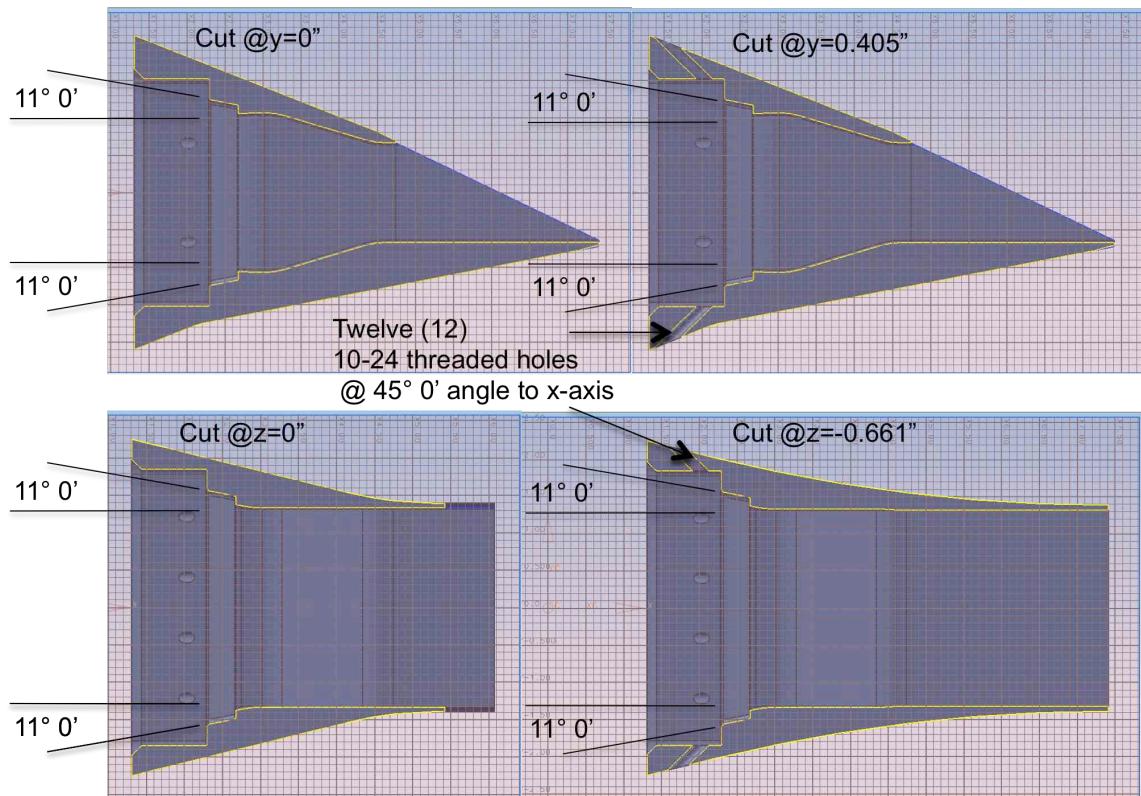


FIGURE 6 PARTID NA2B2—REFERENCE CROSS-SECTION

TABLE 4 INSPECTION POINTS FOR PARTID NA2B2

| NA2B2 | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|-------------------------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.523 | 1.000 | 0.000 | 1.697 -1.729 |
| 1.100 | 0.000 | ±1.221 | 2.931 | 0.000 | 0.922 -1.347 |
| 1.300 | 0.000 | ±1.182 | 1.000 | ±1.999 | 0.000 |
| 1.400 | 0.000 | ±1.056 | 2.931 | ±1.622 | 0.000 |
| 1.700 | 0.000 | ±1.068 | | | |
| 3.000 | 0.000 | ±0.717 | | | |
| 3.231 | 0.000 | ±0.670 | | | |
| 3.431 | 0.000 | ±0.667 | | | |
| 0.200 | ±1.850 | 0.000 | | | |
| 1.100 | ±1.543 | 0.000 | | | |
| 1.300 | ±1.504 | 0.000 | | | |
| 1.400 | ±1.368 | 0.000 | | | |
| 1.700 | ±1.335 | 0.000 | | | |
| 3.000 | ±1.335 | 0.000 | | | |
| 3.231 | ±1.335 | 0.000 | | | |
| 3.431 | ±1.335 | 0.000 | | | |

2.1.4 NA2K1, Cutback nozzle, 2:1, 1.3" ext

Views of the part are given in Figure 7. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 8.

Inspection points are given in Table 5.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 4.766"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface, shown in Reference cross-section, is considered a mating surface for tolerance and surface finish purposes.

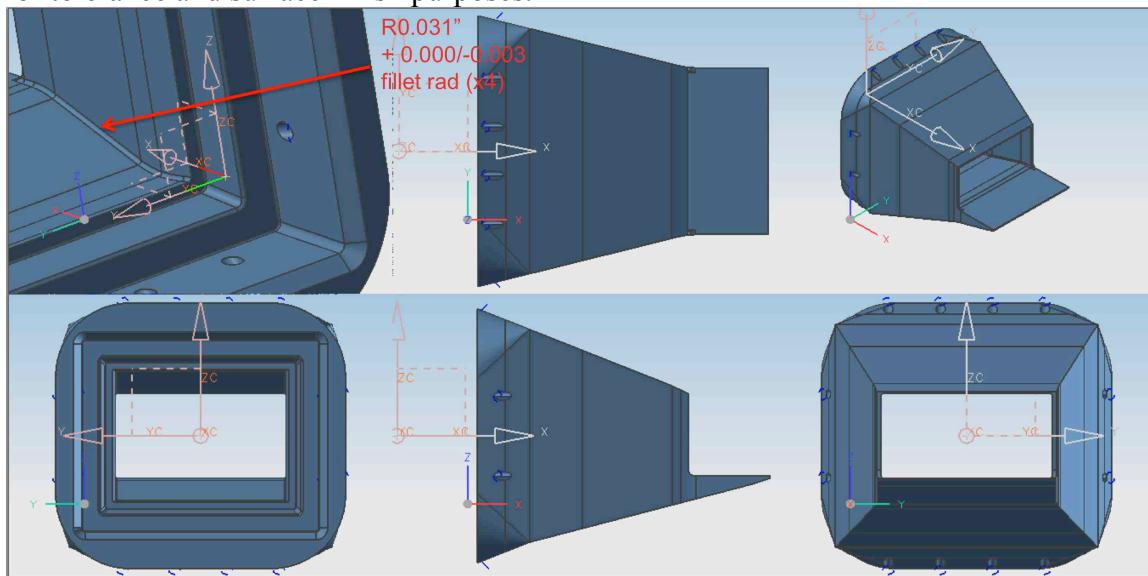


FIGURE 7 PART ID NA2K1—SIX VIEWS

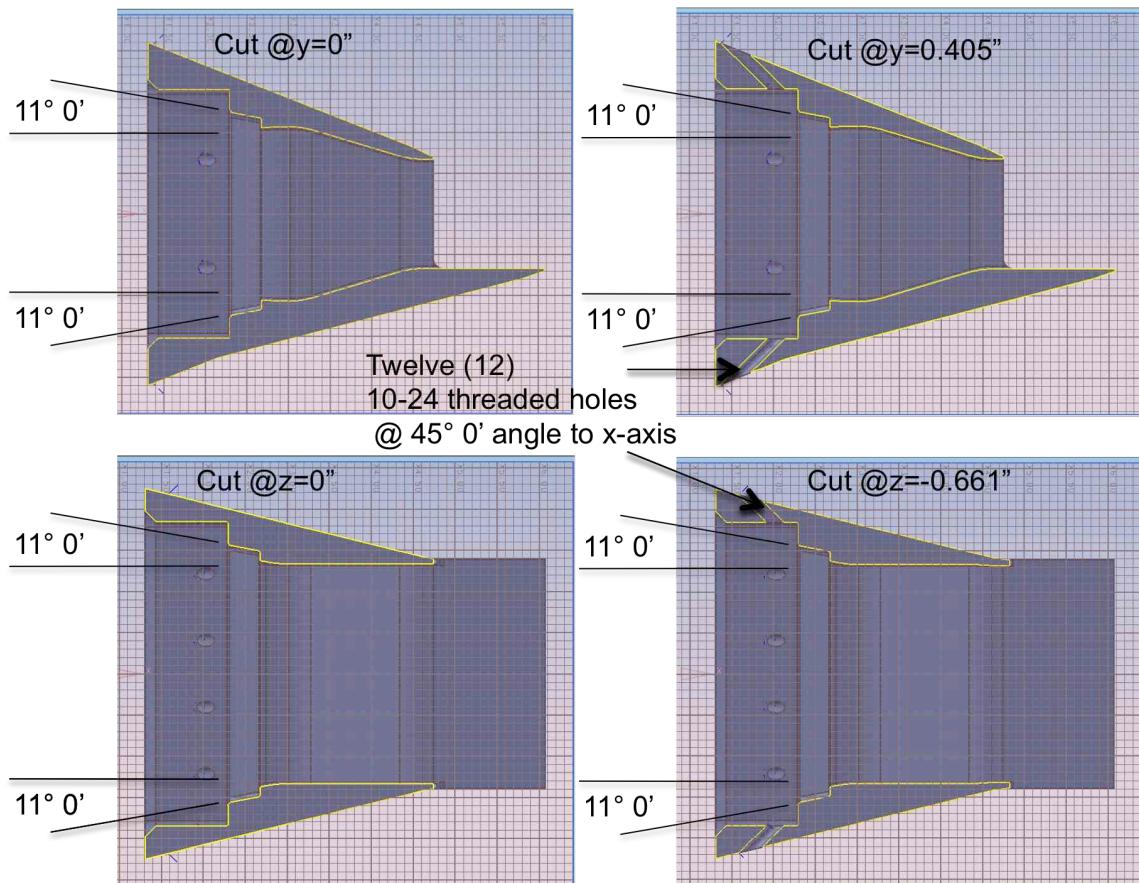


FIGURE 8 PARTID NA2K1—REFERENCE CROSS-SECTIONS

TABLE 5 INSPECTION POINTS FOR PARTID NA2K1

| NA2K1 | | | | | |
|-------------------|-------------------------------|-------------------------------|-------------------|-------------------------------|--------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ± 1.523 | 1.000 | 0.000 | 1.697 |
| 1.100 | 0.000 | ± 1.221 | 2.931 | 0.000 | 0.922 |
| 1.300 | 0.000 | ± 1.182 | 1.000 | ± 1.998 | 0.000 |
| 1.400 | 0.000 | ± 1.056 | 2.931 | ± 1.513 | 0.000 |
| 1.700 | 0.000 | ± 1.068 | | | |
| 3.000 | 0.000 | ± 0.717 | | | |
| 3.231 | 0.000 | ± 0.670 | | | |
| 3.431 | 0.000 | ± 0.667 | | | |
| 0.200 | ± 1.850 | 0.000 | | | |
| 1.100 | ± 1.543 | 0.000 | | | |
| 1.300 | ± 1.504 | 0.000 | | | |
| 1.400 | ± 1.368 | 0.000 | | | |
| 1.700 | ± 1.335 | 0.000 | | | |
| 3.000 | ± 1.335 | 0.000 | | | |
| 3.231 | ± 1.335 | 0.000 | | | |
| 3.431 | ± 1.335 | 0.000 | | | |

2.1.5 NA2C1, Chevron nozzle, 2:1, design 1

Views of the part are given in Figure 9. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 10.

Inspection points are given in Table 6.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 4.099"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface shown in Reference cross-section is considered a mating surface for tolerance and surface finish purposes.

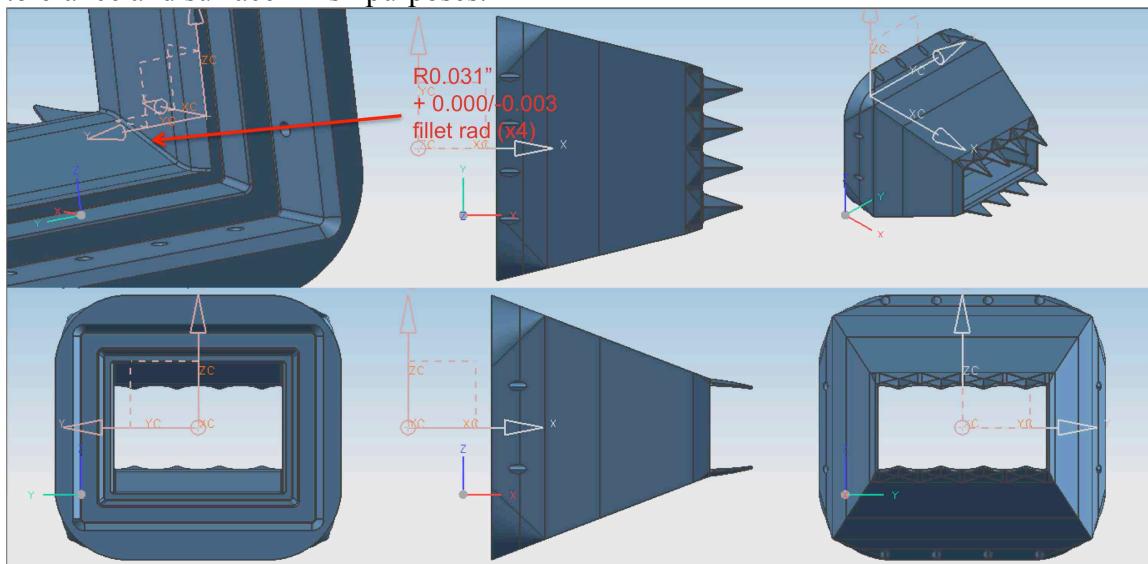


FIGURE 9 PART ID NA2C1—SIX VIEWS

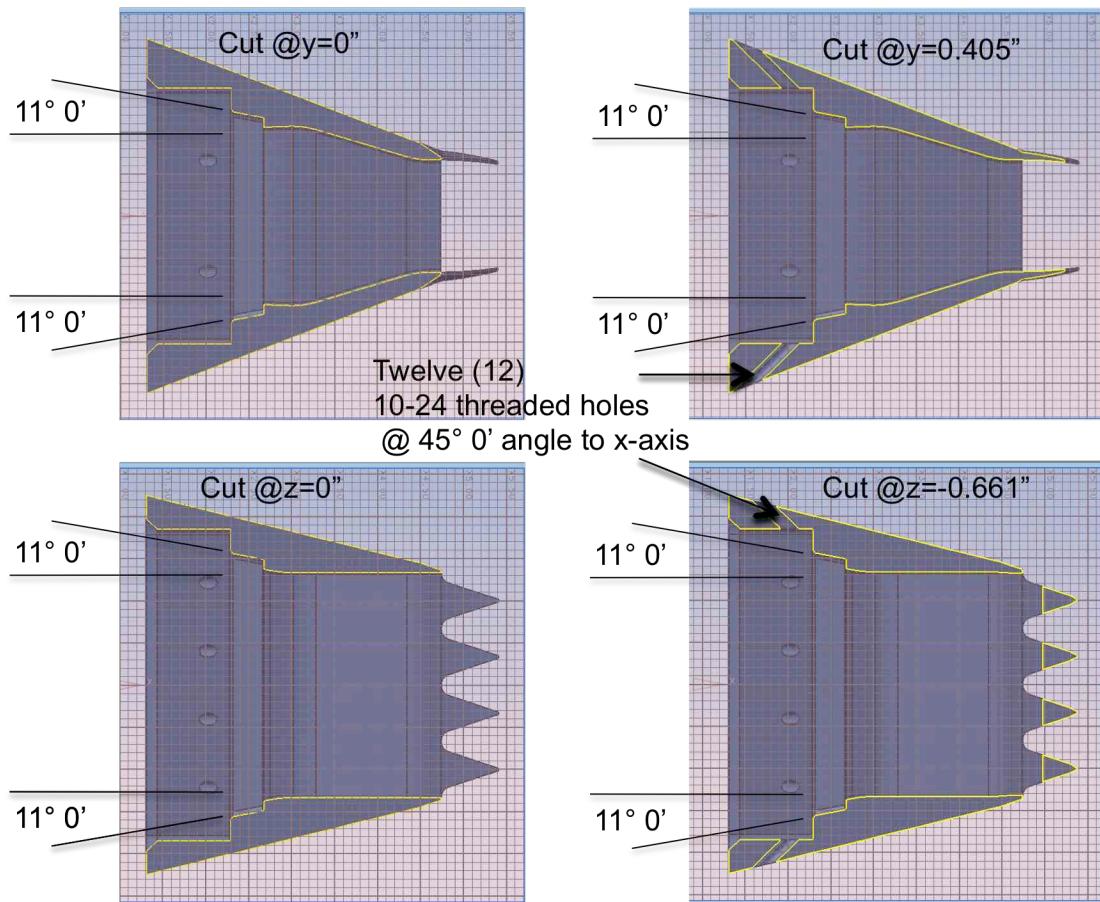


FIGURE 10 PARTID NA2C1—REFERENCE CROSS-SECTIONS

TABLE 6 INSPECTION POINTS FOR PARTID NA2C1

| NA2C1 | | | | | |
|-------------------|-------------------------------|-------------------------------|-------------------|-------------------------------|-------------------------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ± 1.523 | 1.000 | 0.000 | ± 1.721 |
| 1.100 | 0.000 | ± 1.221 | 2.931 | 0.000 | ± 0.969 |
| 1.300 | 0.000 | ± 1.182 | 1.000 | ± 1.998 | 0.000 |
| 1.400 | 0.000 | ± 1.056 | 2.931 | ± 1.513 | 0.000 |
| 1.700 | 0.000 | ± 1.068 | | | |
| 3.000 | 0.000 | ± 0.717 | | | |
| 3.231 | 0.000 | ± 0.670 | | | |
| 3.431 | 0.000 | ± 0.667 | | | |
| 4.099 | -1.001 | ± 0.617 | | | |
| 4.099 | -0.334 | ± 0.617 | | | |
| 4.099 | 0.334 | ± 0.617 | | | |
| 4.099 | 1.001 | ± 0.617 | | | |
| 0.200 | ± 1.850 | 0.000 | | | |
| 1.100 | ± 1.543 | 0.000 | | | |
| 1.300 | ± 1.504 | 0.000 | | | |
| 1.400 | ± 1.368 | 0.000 | | | |
| 1.700 | ± 1.335 | 0.000 | | | |

| | | |
|-------|---------------|-------|
| 3.000 | ±1.335 | 0.000 |
| 3.231 | ±1.335 | 0.000 |
| 3.431 | ±1.335 | 0.000 |

2.1.6 NA2C2, Chevron nozzle, 2:1, design 2

Views of the part are given in Figure 11. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 12.

Inspection points are given in Table 7.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 3.765"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface shown in Reference cross-section is considered a mating surface for tolerance and surface finish purposes.

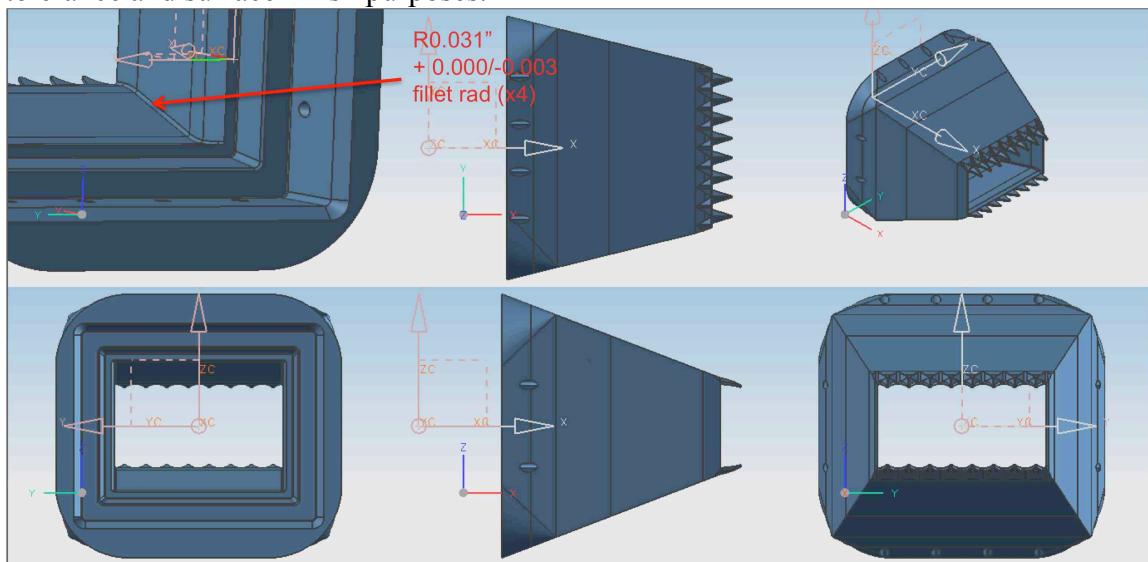


FIGURE 11 PARTID NA2C2—SIX VIEWS

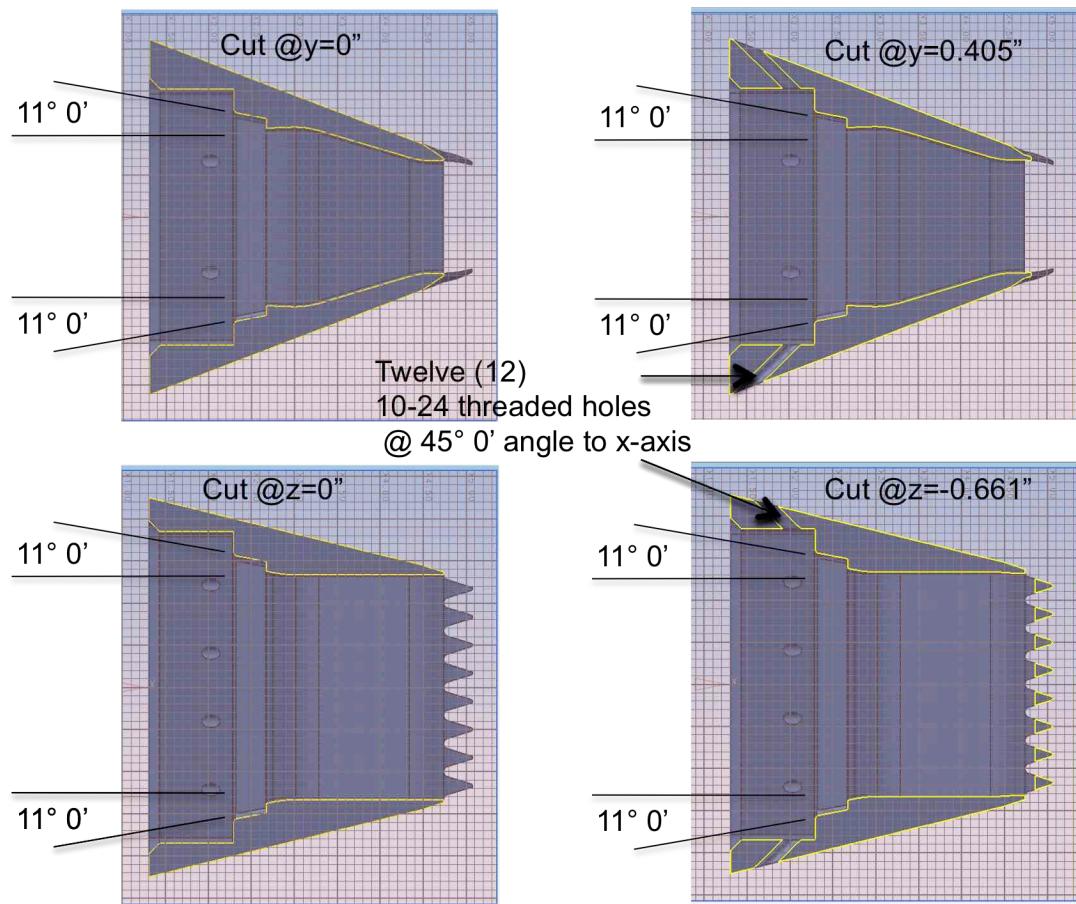


FIGURE 12 PARTID NA2C2—REFERENCE CROSS-SECTION

TABLE 7 INSPECTION POINTS FOR PARTID NA2C2

| NA2C2 | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|---------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.523 | 1.000 | 0.000 | ±1.721 |
| 1.100 | 0.000 | ±1.221 | 2.931 | 0.000 | ±0.969 |
| 1.300 | 0.000 | ±1.182 | 1.000 | ±1.998 | 0.000 |
| 1.400 | 0.000 | ±1.056 | 2.931 | ±1.513 | 0.000 |
| 1.700 | 0.000 | ±1.068 | | | |
| 3.000 | 0.000 | ±0.717 | | | |
| 3.231 | 0.000 | ±0.670 | | | |
| 3.431 | 0.000 | ±0.667 | | | |
| 3.765 | -1.168 | ±0.617 | | | |
| 3.765 | -0.834 | ±0.617 | | | |
| 3.765 | -0.501 | ±0.617 | | | |
| 3.765 | -0.167 | ±0.617 | | | |
| 3.765 | 0.167 | ±0.617 | | | |
| 3.765 | 0.501 | ±0.617 | | | |
| 3.765 | 0.834 | ±0.617 | | | |
| 3.765 | 1.168 | ±0.617 | | | |
| 0.200 | ±1.850 | 0.000 | | | |



| | | |
|-------|---------------|-------|
| 1.100 | ±1.543 | 0.000 |
| 1.300 | ±1.504 | 0.000 |
| 1.400 | ±1.368 | 0.000 |
| 1.700 | ±1.335 | 0.000 |
| 3.000 | ±1.335 | 0.000 |
| 3.231 | ±1.335 | 0.000 |
| 3.431 | ±1.335 | 0.000 |

2.1.7 NA2C3, Chevron nozzle, 2:1, design 3

Views of the part are given in Figure 13. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 14.

Inspection points are given in Table 8.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 4.099"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface shown in Reference cross-section is considered a mating surface for tolerance and surface finish purposes.

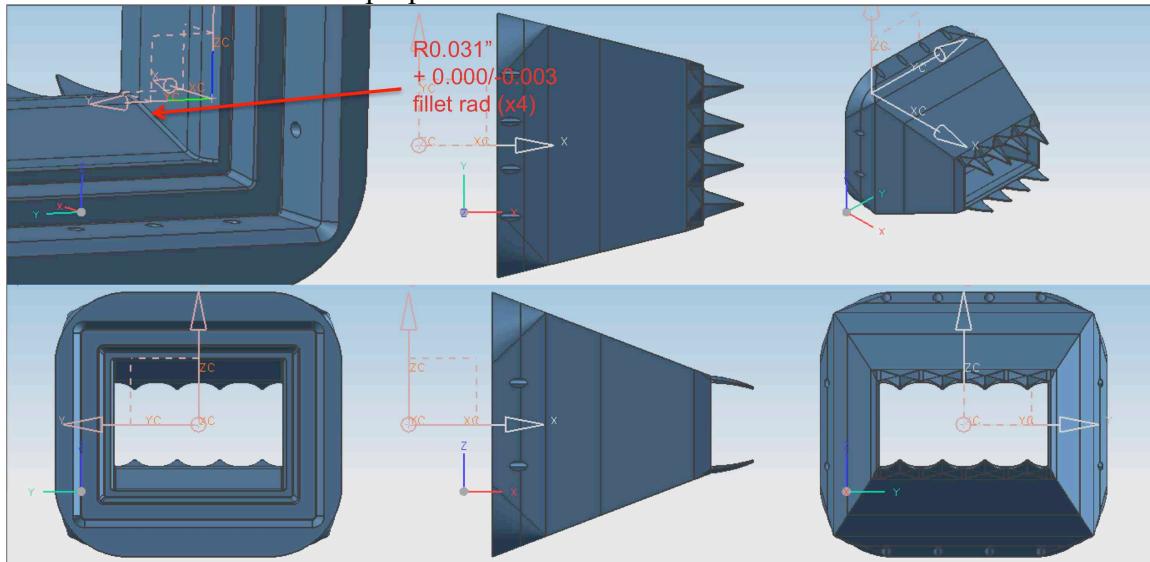


FIGURE 13 PART ID NA2C3—SIX VIEWS

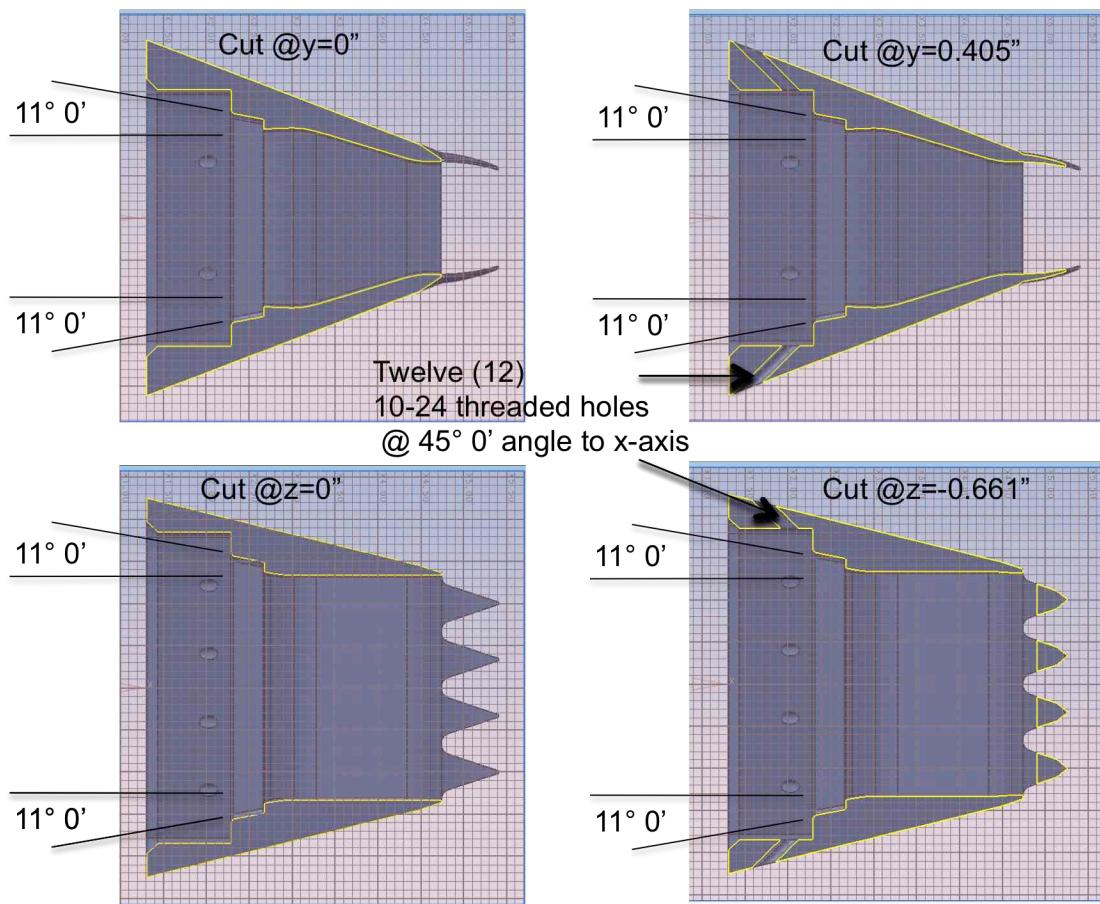


FIGURE 14 PARTID NA2C3—REFERENCE CROSS-SECTIONS

TABLE 8 INSPECTION POINTS FOR PARTID NA2C3

| NA2C3 | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|---------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.523 | 1.000 | 0.000 | ±1.721 |
| 1.100 | 0.000 | ±1.221 | 2.931 | 0.000 | ±0.969 |
| 1.300 | 0.000 | ±1.182 | 1.000 | ±1.998 | 0.000 |
| 1.400 | 0.000 | ±1.056 | 2.931 | ±1.513 | 0.000 |
| 1.700 | 0.000 | ±1.068 | | | |
| 3.000 | 0.000 | ±0.717 | | | |
| 3.231 | 0.000 | ±0.670 | | | |
| 3.431 | 0.000 | ±0.667 | | | |
| 4.099 | -1.001 | ±0.567 | | | |
| 4.099 | -0.334 | ±0.567 | | | |
| 4.099 | 0.334 | ±0.567 | | | |
| 4.099 | 1.001 | ±0.567 | | | |
| 0.200 | ±1.850 | 0.000 | | | |
| 1.100 | ±1.543 | 0.000 | | | |
| 1.300 | ±1.504 | 0.000 | | | |
| 1.400 | ±1.368 | 0.000 | | | |
| 1.700 | ±1.335 | 0.000 | | | |

| | | |
|-------|---------------|-------|
| 3.000 | ±1.335 | 0.000 |
| 3.231 | ±1.335 | 0.000 |
| 3.431 | ±1.335 | 0.000 |

2.1.8 NA2BC1, Bevel nozzle w/chevron, 2:1, design 1

Views of the part are given in Figure 15. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 16.

Inspection points are given in Table 9.

Nominal dimensions:

Max included diameter (centered about x-axis) = 5.38"

Length = 6.100"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface shown in Reference cross-section is considered a mating surface for tolerance and surface finish purposes.

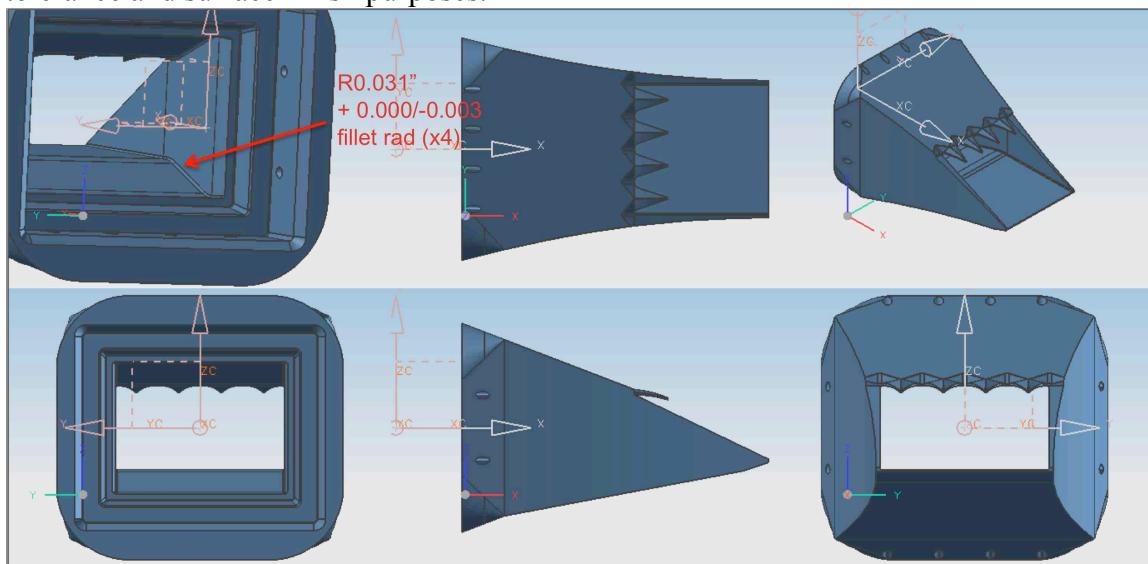


FIGURE 15 PARTID NA2BC1—SIX VIEWS

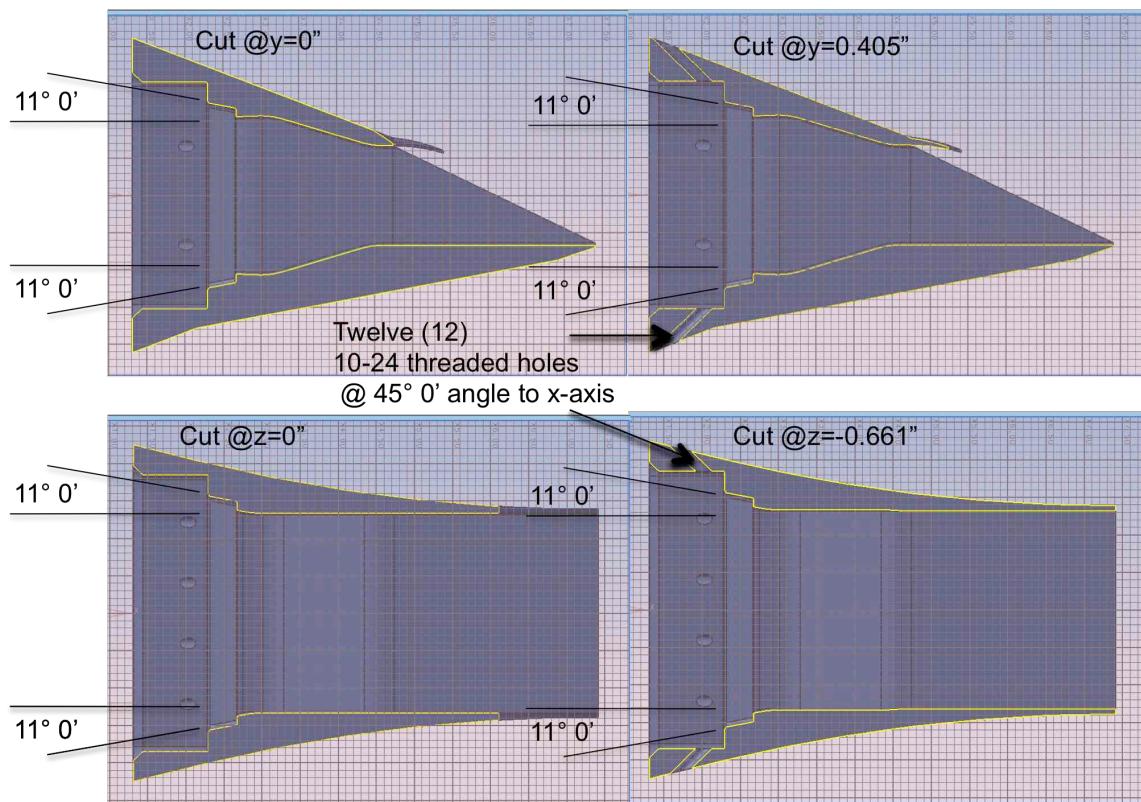


FIGURE 16 PARTID NA2BC1—REFERENCE CROSS-SECTION

TABLE 9 INSPECTION POINTS FOR PARTID NA2BC1

| NA2BC1 | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|-------------------------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.523 | 1.000 | 0.000 | 1.721 -1.752 |
| 1.100 | 0.000 | ±1.221 | 2.931 | 0.000 | 0.969 -1.381 |
| 1.300 | 0.000 | ±1.182 | 1.000 | ±1.999 | 0.000 |
| 1.400 | 0.000 | ±1.056 | 2.931 | ±1.622 | 0.000 |
| 1.700 | 0.000 | ±1.068 | | | |
| 3.000 | 0.000 | ±0.717 | | | |
| 3.231 | 0.000 | ±0.670 | | | |
| 3.431 | 0.000 | ±0.667 | | | |
| 4.099 | -1.001 | ±0.567 | | | |
| 4.099 | -0.334 | ±0.567 | | | |
| 4.099 | 0.334 | ±0.567 | | | |
| 4.099 | 1.001 | ±0.567 | | | |
| 0.200 | ±1.850 | 0.000 | | | |
| 1.100 | ±1.543 | 0.000 | | | |
| 1.300 | ±1.504 | 0.000 | | | |
| 1.400 | ±1.368 | 0.000 | | | |
| 1.700 | ±1.335 | 0.000 | | | |
| 3.000 | ±1.335 | 0.000 | | | |
| 3.231 | ±1.335 | 0.000 | | | |



| | | |
|-------|-------------|-------|
| 3.431 | ± 1.335 | 0.000 |
|-------|-------------|-------|

2.1.9 NA4Z, Baseline rectangular nozzle, 4:1

Views of the part are given in Figure 17. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 18.

Inspection points are given in Table 10. See Section 3.2 for details on inspections.

Nominal dimensions:

Max included diameter (centered about x-axis) = 6.063"

Length = 3.520"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface, shown in Reference cross-section, is considered a mating surface for tolerance and surface finish purposes.

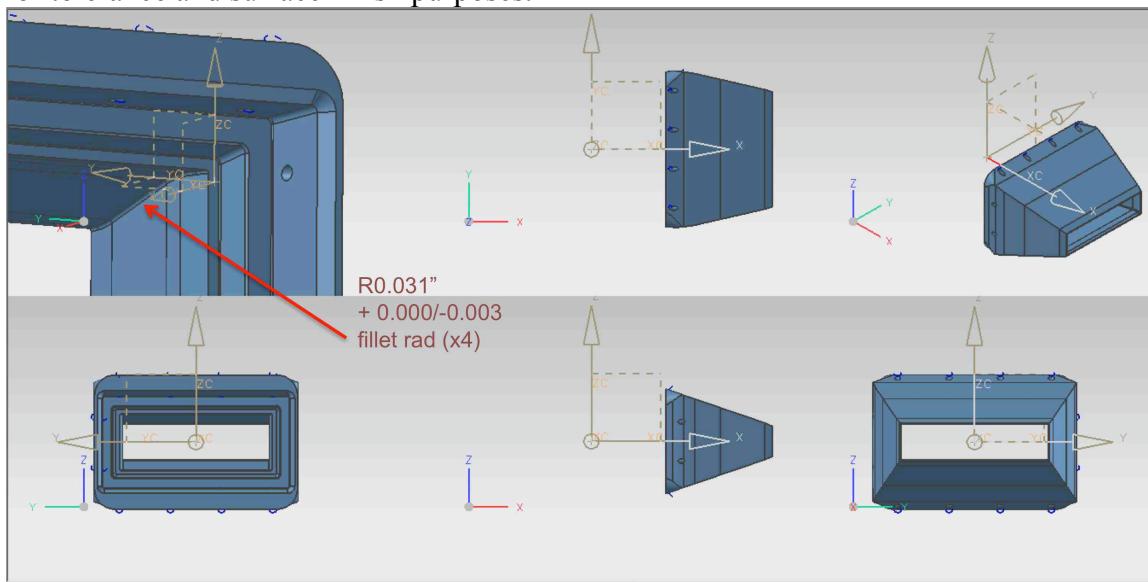


FIGURE 17 PART ID NA4Z—SIX VIEWS

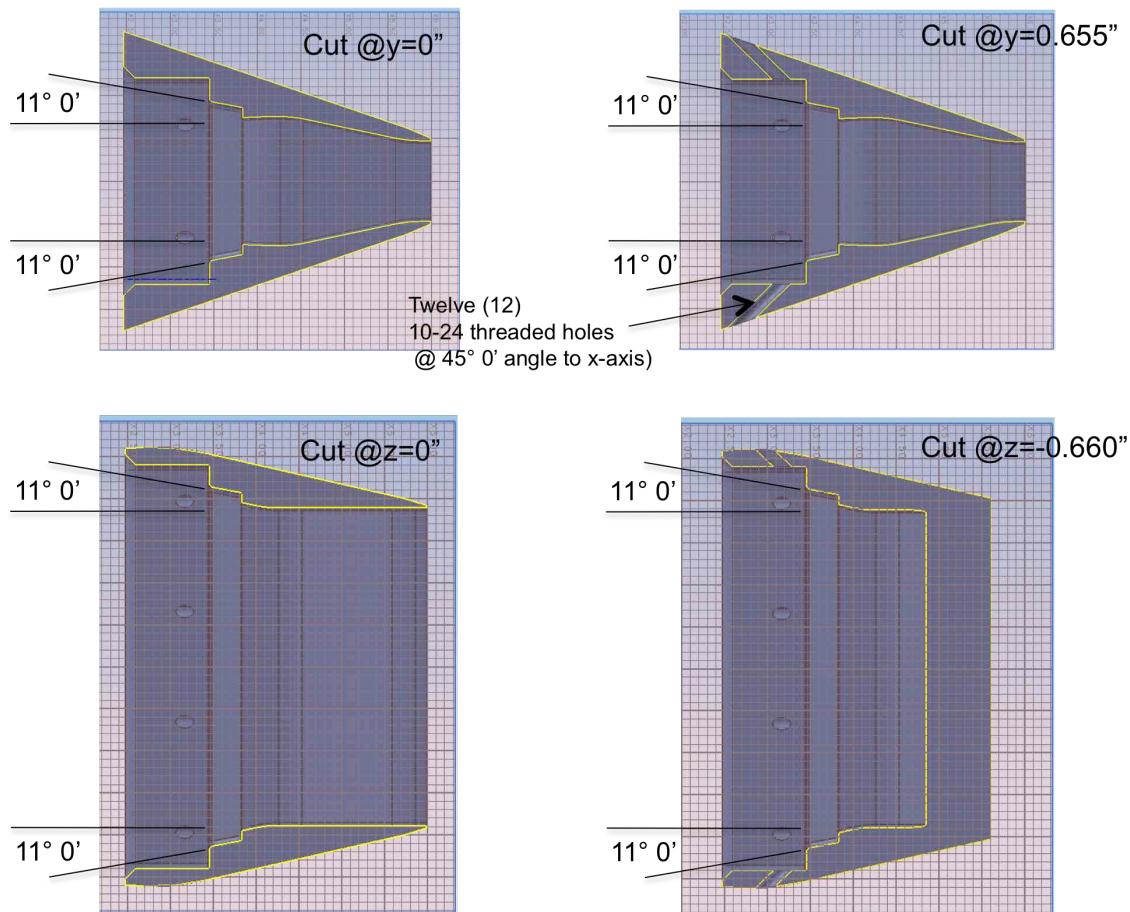


FIGURE 18 PARTID NA4Z—REFERENCE CROSS-SECTIONS

TABLE 10 INSPECTION POINTS FOR PARTID NA4Z

| NA4Z | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|---------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.211 | 1.000 | 0.000 | ±1.402 |
| 1.100 | 0.000 | ±0.910 | 3.020 | 0.000 | ±0.699 |
| 1.300 | 0.000 | ±0.871 | 1.000 | ±2.524 | 0.000 |
| 1.400 | 0.000 | ±0.744 | 3.020 | ±2.056 | 0.000 |
| 1.800 | 0.000 | ±0.756 | | | |
| 3.100 | 0.000 | ±0.505 | | | |
| 3.320 | 0.000 | ±0.474 | | | |
| 3.520 (end) | 0.000 | ±0.472 | | | |
| 0.200 | ±2.402 | 0.000 | | | |
| 1.100 | ±2.118 | 0.000 | | | |
| 1.300 | ±2.454 | 0.000 | | | |
| 1.400 | ±1.943 | 0.000 | | | |
| 1.800 | ±1.887 | 0.000 | | | |
| 3.100 | ±1.887 | 0.000 | | | |
| 3.320 | ±1.887 | 0.000 | | | |
| 3.520 (end) | ±1.887 | 0.000 | | | |

2.1.10 NA4B1, Bevel nozzle, 4:1, 1.3" ext

Views of the part are given in Figure 19. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 20.

Inspection points are given in Table 11.

Nominal dimensions:

Max included diameter (centered about x-axis) = 6.063"

Length = 4.854"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface, shown in Reference cross-section, is considered a mating surface for tolerance and surface finish purposes.

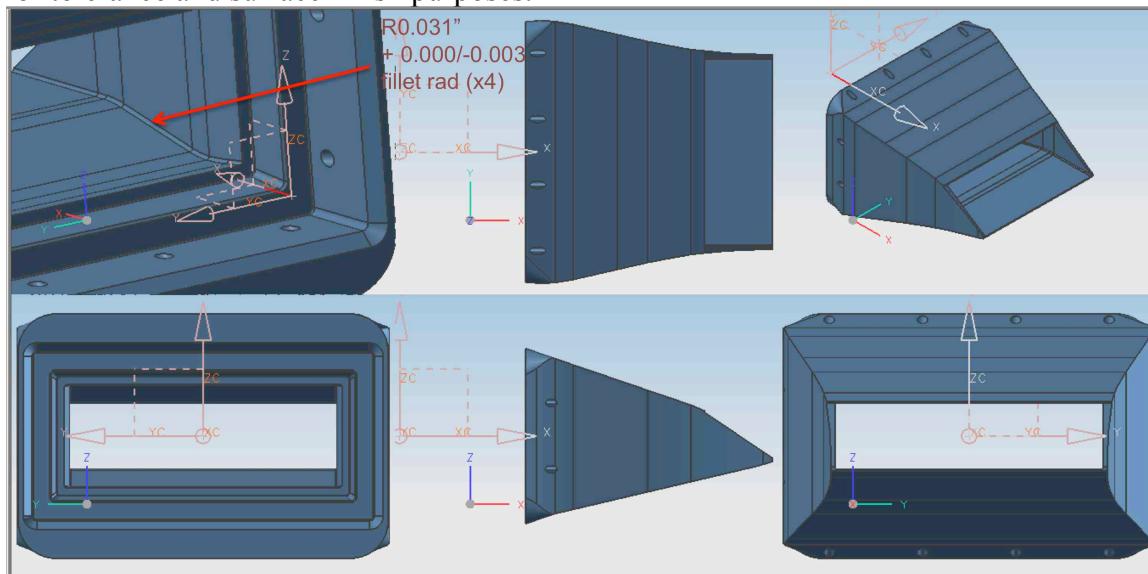


FIGURE 19 PARTID NA4B1—SIX VIEWS

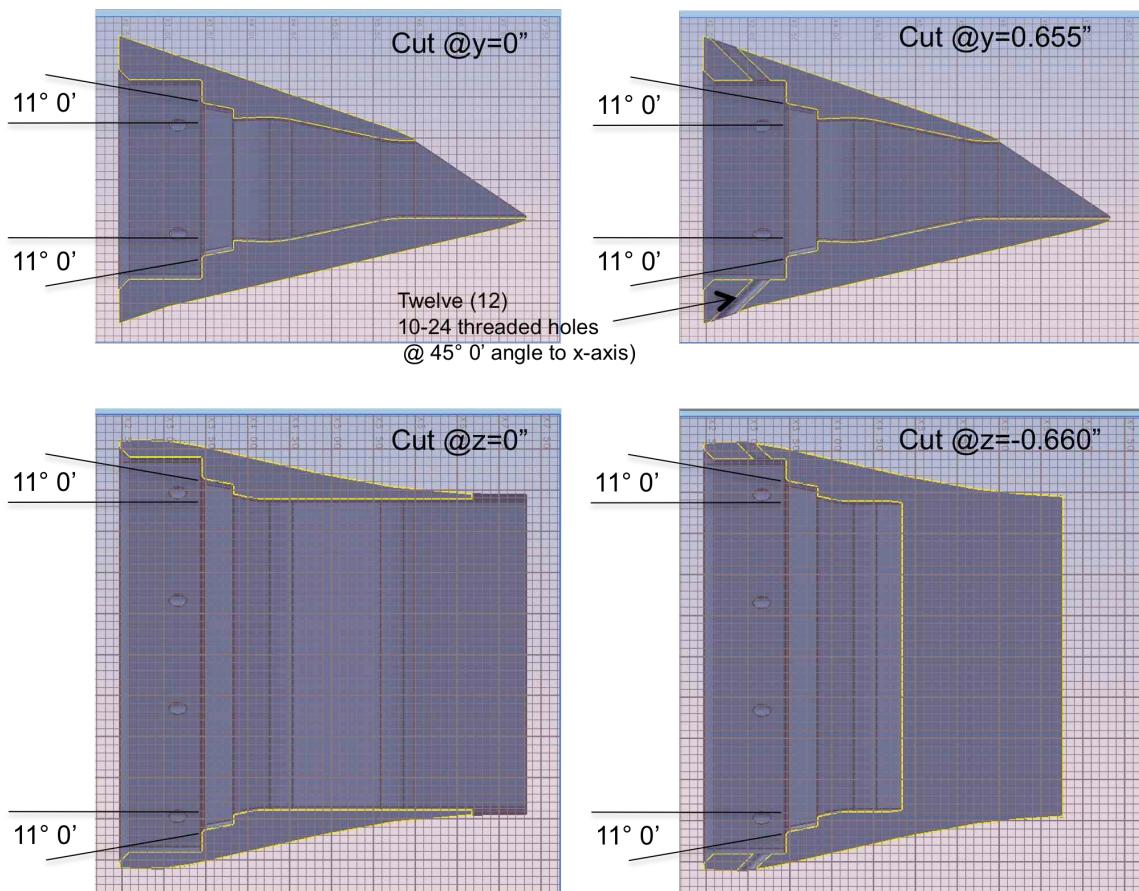


FIGURE 20 PARTID NA4B1—REFERENCE CROSS-SECTION

TABLE 11 INSPECTION POINTS FOR PARTID NA4B1

| NA4B1 | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|-------------------------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.211 | 1.000 | 0.000 | 1.402 -1.448 |
| 1.100 | 0.000 | ±0.910 | 3.020 | 0.000 | 0.699 -0.964 |
| 1.300 | 0.000 | ±0.871 | 1.000 | ±2.524 | 0.000 |
| 1.400 | 0.000 | ±0.744 | 3.020 | ±2.076 | 0.000 |
| 1.800 | 0.000 | ±0.756 | | | |
| 3.100 | 0.000 | ±0.505 | | | |
| 3.320 | 0.000 | ±0.474 | | | |
| 3.520 | 0.000 | ±0.472 | | | |
| 0.200 | ±2.402 | 0.000 | | | |
| 1.100 | ±2.118 | 0.000 | | | |
| 1.300 | ±2.454 | 0.000 | | | |
| 1.400 | ±1.943 | 0.000 | | | |
| 1.800 | ±1.887 | 0.000 | | | |
| 3.100 | ±1.887 | 0.000 | | | |
| 3.320 | ±1.887 | 0.000 | | | |
| 3.520 | ±1.887 | 0.000 | | | |



2.1.11 NA4B2, Bevel nozzle, 4:1, 2.7" ext

Views of the part are given in Figure 21. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 22.

Inspection points are given in Table 12.

Nominal dimensions:

Max included diameter (centered about x-axis) = 6.063"

Length = 6.189"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface, shown in Reference cross-section, is considered a mating surface for tolerance and surface finish purposes.

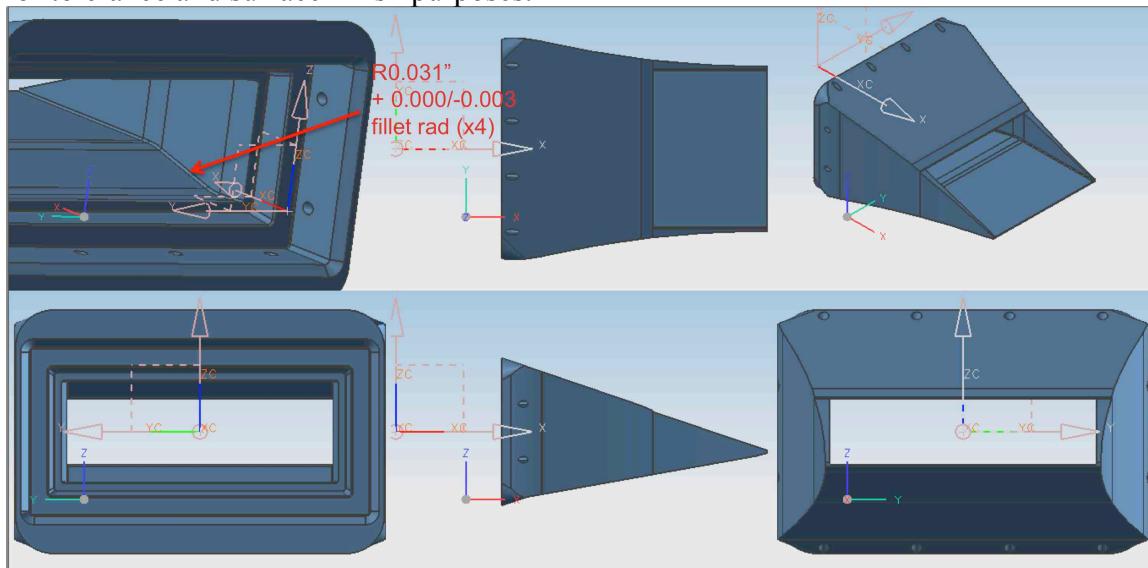


FIGURE 21 PARTID NA4B2—SIX VIEWS

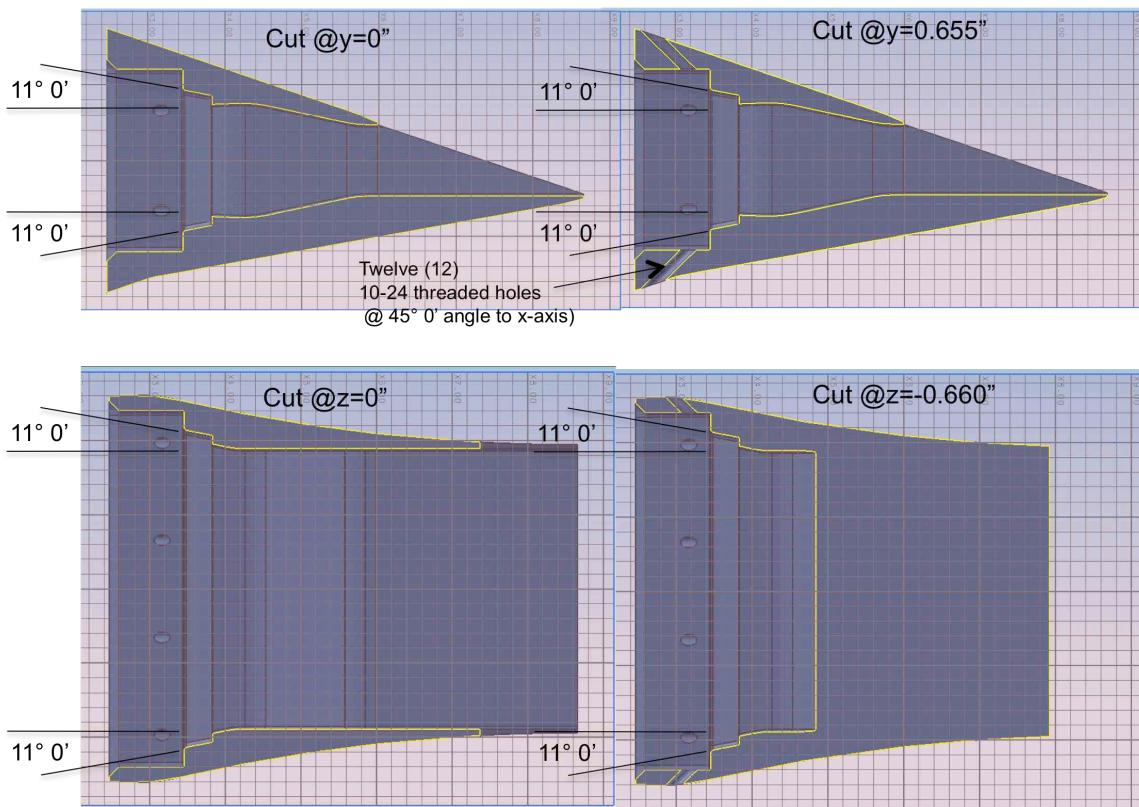


FIGURE 22 PARTID NA4B2—REFERENCE CROSS-SECTION

TABLE 12 INSPECTION POINTS FOR PARTID NA4B2

| NA4B2 | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|---------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.211 | 1.000 | 0.000 | 1.402 |
| 1.100 | 0.000 | ±0.910 | 3.020 | 0.000 | 0.699 |
| 1.300 | 0.000 | ±0.871 | 1.000 | ±2.524 | -1.103 |
| 1.400 | 0.000 | ±0.744 | 3.020 | ±2.155 | 0.000 |
| 1.800 | 0.000 | ±0.756 | | | |
| 3.100 | 0.000 | ±0.505 | | | |
| 3.320 | 0.000 | ±0.474 | | | |
| 3.520 | 0.000 | ±0.472 | | | |
| 0.200 | ±2.402 | 0.000 | | | |
| 1.100 | ±2.118 | 0.000 | | | |
| 1.300 | ±2.454 | 0.000 | | | |
| 1.400 | ±1.943 | 0.000 | | | |
| 1.800 | ±1.887 | 0.000 | | | |
| 3.100 | ±1.887 | 0.000 | | | |
| 3.320 | ±1.887 | 0.000 | | | |
| 3.520 | ±1.887 | 0.000 | | | |

2.1.12 NA4K1, Cutback nozzle, 4:1, 1.3" ext

Views of the part are given in Figure 23. Reference cross-sections pointing out location of threaded holes and critical angle are shown in Figure 24.

Inspection points are given in Table 13.

Nominal dimensions:

Max included diameter (centered about x-axis) = 6.063"

Length = 4.854"

Radius in internal corners of rectangular duct is specified as 0.031" in the solid model.

Threaded holes are 10-24 UNC threaded through.

Internal 11° angled surface shown in Reference cross-section is considered a mating surface for tolerance and surface finish purposes.

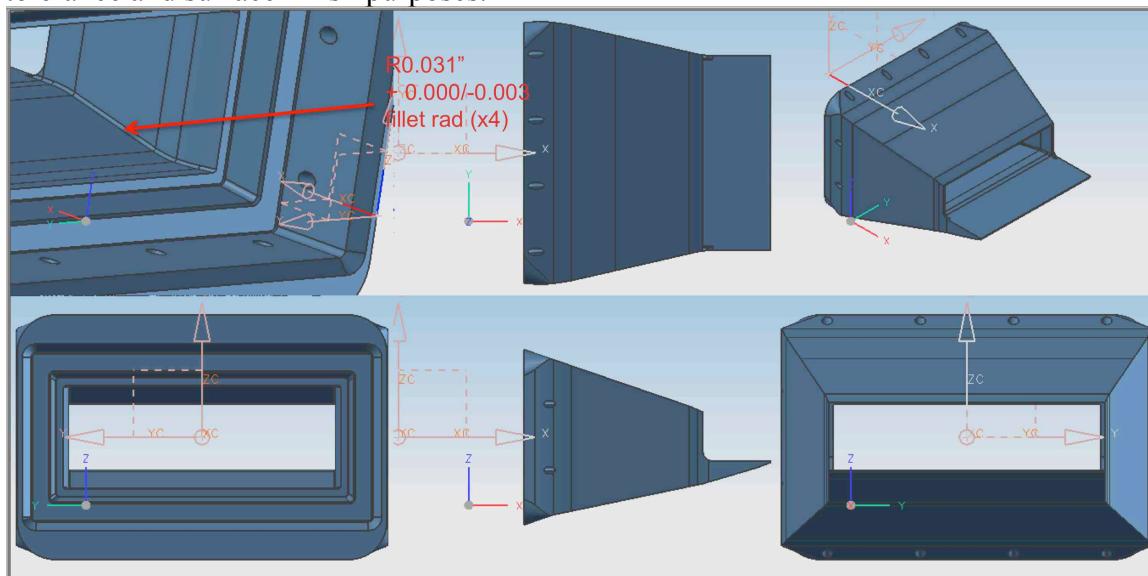


FIGURE 23 PARTID NA4K1—SIX VIEWS

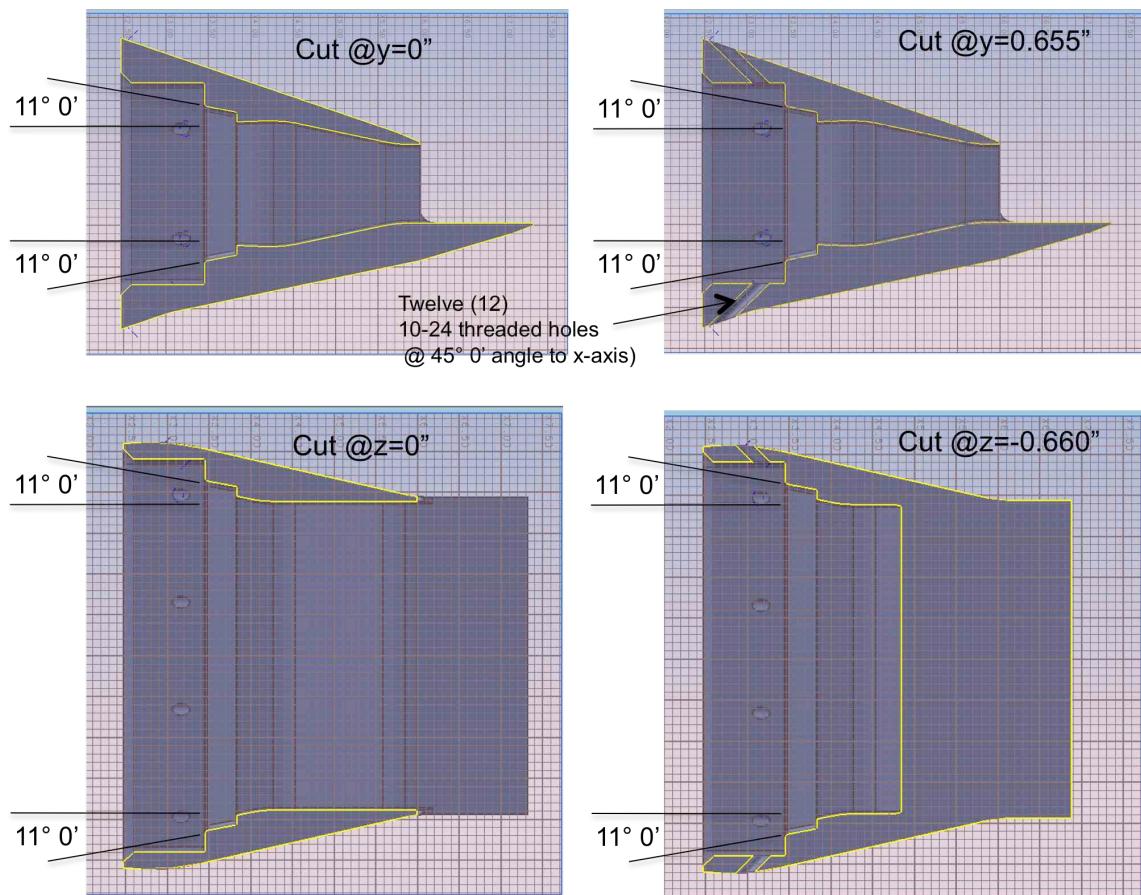


FIGURE 24 PARTID NA4K1—REFERENCE CROSS-SECTION

TABLE 13 INSPECTION POINTS FOR PARTID NA4K1

| NA4K1 | | | | | |
|-------------------|---------------|---------------|-------------------|---------------|-------------------------------|
| Internal surfaces | | | External surfaces | | |
| x | y | z | x | y | z |
| 0.200 | 0.000 | ±1.211 | 1.000 | 0.000 | 1.402 -1.459 |
| 1.100 | 0.000 | ±0.910 | 3.020 | 0.000 | 0.699 -1.031 |
| 1.300 | 0.000 | ±0.871 | 1.000 | ±2.524 | 0.000 |
| 1.400 | 0.000 | ±0.744 | 3.020 | ±2.056 | 0.000 |
| 1.800 | 0.000 | ±0.756 | | | |
| 3.100 | 0.000 | ±0.505 | | | |
| 3.320 | 0.000 | ±0.474 | | | |
| 3.520 | 0.000 | ±0.472 | | | |
| 0.200 | ±2.402 | 0.000 | | | |
| 1.100 | ±2.118 | 0.000 | | | |
| 1.300 | ±2.454 | 0.000 | | | |
| 1.400 | ±1.943 | 0.000 | | | |
| 1.800 | ±1.887 | 0.000 | | | |
| 3.100 | ±1.887 | 0.000 | | | |
| 3.320 | ±1.887 | 0.000 | | | |
| 3.520 | ±1.887 | 0.000 | | | |



2.2 Assemblies

Assemblies will consist of two pieces: each of the Nozzles in each series of aspect ratios connected to the Round to Rectangular Transition Ducts of the same aspect ratio. The nozzles are interchangeable with the transition ducts that have the same aspect ratio. The transition duct, shown in Figure 25 (2:1 aspect ratio) and Figure 27 (4:1 aspect ratio), will be provided to the vendor for final fit up. Cross-sections of the Round-to-Rectangular Duct and Baseline Rectangular Nozzles for the two different aspect ratios are shown in Figure 26 and Figure 28. A representative total assembly, including parts not to be fabricated under this Statement of Work, is shown in Figure 29 for reference.

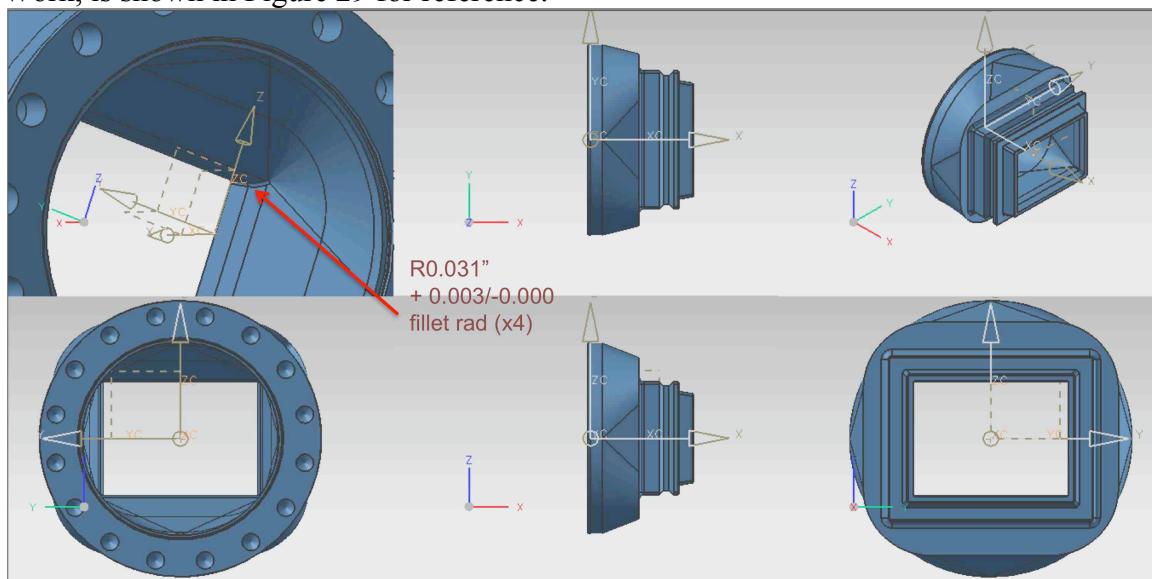


FIGURE 25 GOVERNMENT FURNISHED EQUIPMENT, PARTID DR2A2--SIX VIEWS

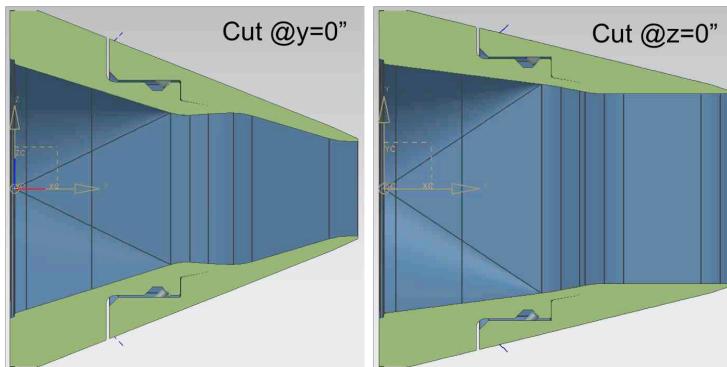


FIGURE 26 ASSEMBLY CROSS-SECTION INCLUDING DR2A2, NA2Z

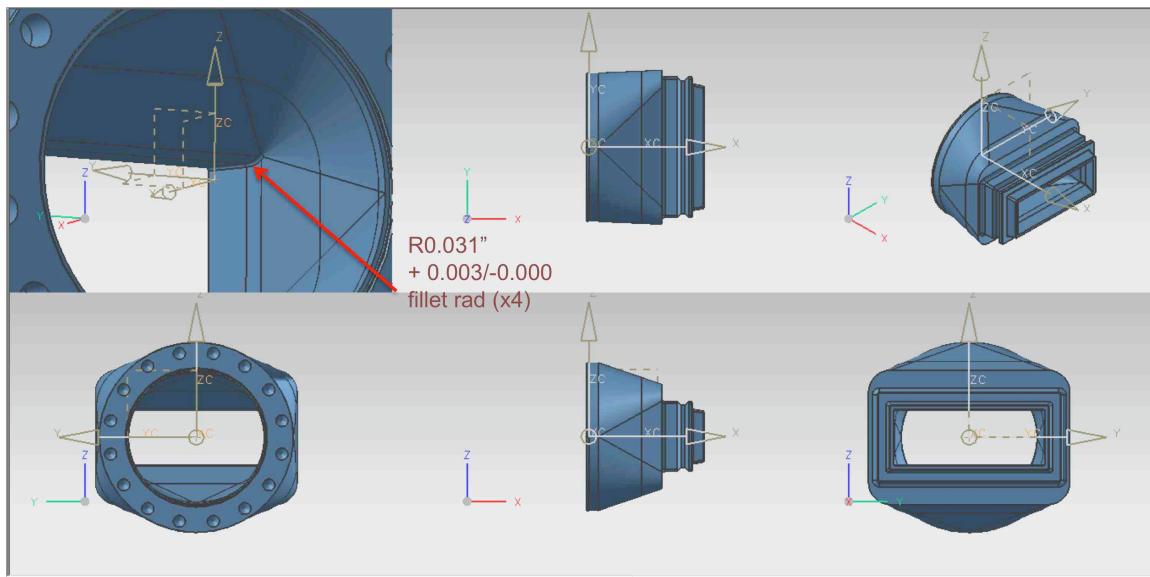


FIGURE 27 GOVERNMENT FURNISHED EQUIPMENT, PARTID DR2A4--SIX VIEWS

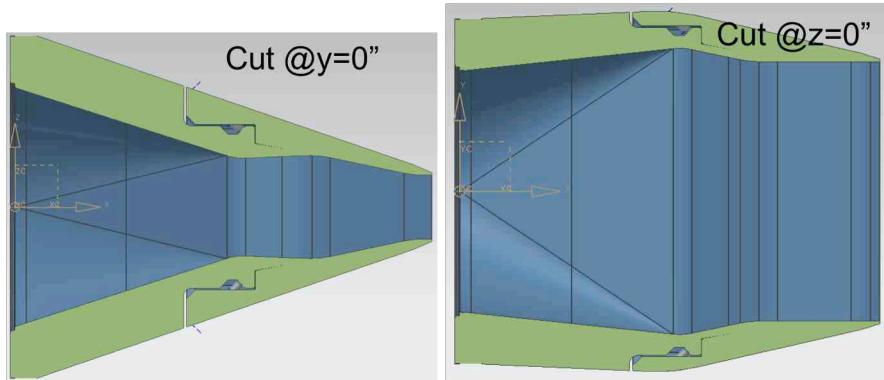


FIGURE 28 ASSEMBLY CROSS-SECTION INCLUDING DR2A4, NA4Z

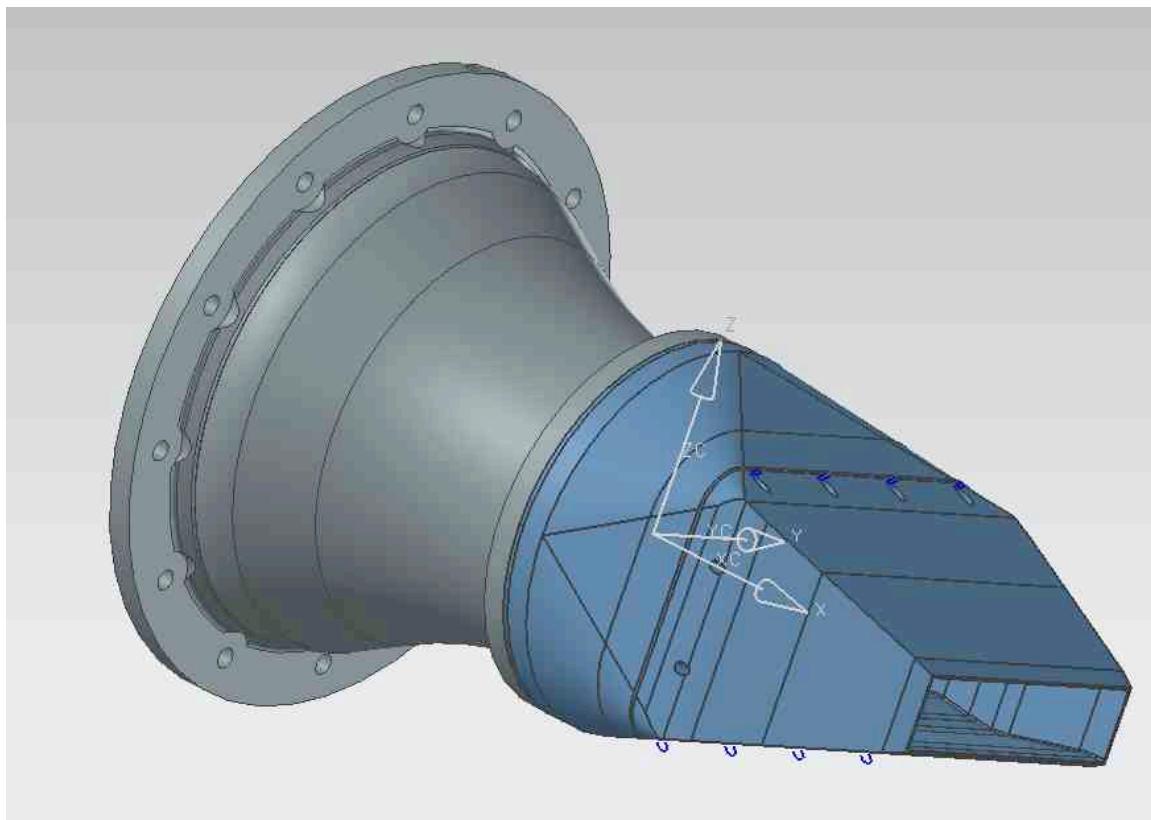


FIGURE 29 TYPICAL ASSEMBLY INCLUDING DS2TJ, DR2A4, AND NA4Z.

3. MODEL FABRICATION REQUIREMENTS

3.1 Design – General

All parts will be machined from the solid model (CAD) files. No formal drawings will be released. Reference figures in this package, along with detailed specifications in Section 2.1, are used to supplement design details such as fasteners, tolerances, and surface finish. If any contour changes outside the specified tolerances are required for manufacturing, the Requester shall approve any such contour changes before fabrication of the hardware.

3.2 Inspection

The Contractor shall inspect a given number of locations on the parts to validate that they meet tolerances relative to the solid model file.

Part Origin: Each component has its origin (0, 0, 0) at the intersection of its centerline and the most upstream vertical plane that is tangent to the part. Flow direction shown in all diagrams is left to right so that the most upstream vertical plane is its left face. Looking at Figure 29, for example, the flow goes through the round to round, then the round to rectangular, and finally through the rectangular nozzle, exiting the nozzle to the right.



Part Inspection: The Contractor shall provide an inspection report detailing how each part meets or deviates from specified values listed in tables provided. No other part feature needs to be inspected at this time. The surface finishes, however, do need to be verified.

Assembly Inspection: The Contractor shall provide an additional inspection report detailing how each of the assemblies meets or deviates from requirements. Assembly and disassembly for this purpose is the responsibility of the contractor. Torque values, fasteners, and specific procedures if necessary, will be provided.

Assembly Inspection Requirements: The face gap between the round to rectangular adapter and any nozzle should nominally be less than 0.005". Report should state what the actual number is.

Trained Quality Assurance personnel shall conduct or witness all inspections unless otherwise agreed to by the Government. Inspection documentation certifying that all tolerances and surface finishes have been achieved (or not) shall be included in the inspection report.

3.3 Tolerances and Finish

Radial tolerances on internal flow surfaces are $\pm 0.002"$ except near joints and nozzle lips where the radial tolerances are $\pm 0.001"$. Tolerances on mating surfaces are held to within $\pm 0.001"$. Note that the angled surfaces of 10° and 11° are mating surfaces. Finish on mating surfaces between parts is 32 $\mu\text{-in}$, on internal flow surfaces is 64 $\mu\text{-in}$, and on all other surfaces is 125 $\mu\text{-in}$. Specifically:

Internal flow surfaces: $\pm 0.002"$ radial from part centerline

Except within 0.5" of a mating face where it becomes:

$\pm 0.001"$ radial from part centerline

(All surfaces including male/female overlapped regions)

Male/Female interfaces:

Male: +0.000"/-0.002" diameter

Female: +0.002"/-0.000" diameter

Corner radii at interface of round to rectangular and rectangular to rectangular:

Round to rectangular: +0.003"/-0.000"

Rectangular to rectangular: +0.000"/-0.003"

In addition at all interfaces:

Upstream facing interior steps will be: +0.000 / - 0.002

3.4 Materials

All machined parts will be fabricated from 316 (not 316L) stainless steel per ASME-SA-479. Material may be substituted only after approval of Requestor.



3.5 Material Certification

All machined materials supplied under this task shall be certified by the supplier that they meet the material specification called for in Section 2.1. Chemical and physical data shall be provided as part of the QA&IP. Heat treatment certifications shall be provided with documentation of temperature cycles and times at temperature provided as part of the QA&IP.

3.6 Identification

Designated PartID shall be stamped or etched (other methods may be accepted upon review by the Requester) on each model part in an area that is not in an internal flow or on a sealing surface. The raised edges shall be worked flush to the part.

3.7 Acceptance Review Notification

The Contractor shall contact the Requestor approximately one (1) week before scheduled delivery, to arrange for an Acceptance Review.

3.8 Acceptance Review, Packing and Shipping

At the Acceptance Review, the Contractor shall complete a full assembly of all hardware (including assembly to all available Government Furnished Equipment hardware), in all configurations as a basis for final acceptance. An inspection report will be provided at the Acceptance Review for NASA review. All steps and fasteners will be flush and faired to NASA satisfaction prior to acceptance. The contractor shall supply all new boxes and packing material. The contractor shall make shipping arrangements with the NASA contracting officer well ahead of the required on-dock date.

3.9 Status Reports

The Contractor shall provide written biweekly status reports that include percent complete for design and fabrication, a brief summary of work completed during the previous two weeks in design and fabrication, and any required completion date variances. These written biweekly status reports shall be provided via e-mail, fax, or hand-carried to the requestor and contracting officer.

4. COMPLIANCE WITH SPECIFIC STANDARDS/HANDBOOKS

The Contractor shall comply with the following handbooks and standards:

ASME-SA-479—Material specification

5. INSPECTION REQUIREMENTS

5.1 Inspection Requirement

The Contractor shall provide a Quality Assurance & Inspection Package (QA&IP) for the fabrication of the hardware. The QA&IP shall contain documentation/reports that certify every requirement in the SOW has been met, including any supplier certifications of any Contractor-ordered or Contractor-supplied materials and fasteners. Contractor Trained Quality Assurance



personnel shall conduct or witness all inspections unless otherwise agreed to by the Government. Inspection documentation certifying that all tolerances have been achieved shall be included in the QA&IP. All the QA reports, including dimensional measurements, shall also be provided as an electronic document.

6. DELIVERABLE ITEMS

- a) The Extensible Rectangular Nozzle Model as defined by solid models in Table 1 and notes in Section 2.1 of this document.
- b) The Contractor shall provide three (3) copies of the Quality Assurance & Inspection Package (QA&IP), which shall include all QA inspection reports, material certifications, contour geometry inspections and weld certifications/inspections. -- Delivered at time of hardware delivery.
- c) The Contractor shall provide the first written biweekly Status Report via e-mail, fax, or hand-carried to Requester, Frank Kmiecik (Frank.L.Kmiecik@nasa.gov) 2 weeks after the award date of the Delivery Order and every 2 weeks after this date until final delivery of all Deliverable Items.
- d) The Contractor shall provide an appropriate shipping/storage container for the model and all components at time of delivery. The container shall contain markings that identify the Model Title, PartIDs, and Requestor.

7. GOVERNMENT FURNISHED ITEMS

| Item | Quantity | Acquisition Cost | Date To Be Furnished |
|--|------------|------------------|---------------------------------------|
| CAD solid model files for Extensible Rectangular Nozzle Model | 12 | \$0 | Included with solicitation. |
| CAD solid model files for Round-to-Rectangular Transition Ducts, 2:1 and 4:1 | 2 | \$0 | Upon award |
| Round-to-Rectangular Transition Ducts, 2:1 and 4:1 | 2 | \$50,000 | Tentatively available after 7/15/2010 |
| Oval Point Hex Socket Set Screws, 10-24UNC x 5/16" length, 18-8 SS | Sufficient | \$100 | With transition ducts |